2021

Item Relationships using Dublin Core, BIBO, FOAF, and FRBR for Managing Resources of Cultural Heritage : Designing a Prototype Integrated Framework

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Abstract

Modern information technology has been changed in digital preservation. Metadata is an important component in cultural heritage. This paper has discussed the item relationships of different collections with the help of Dublin Core, BIBO (Bibliographic Ontology), FOAF (Friend of a Friend), and FRBR (Functional Requirement for Bibliographic Records) for management of digital cultural heritage resources. Create a common interface for integration of these four metadata vocabulary standards with Omeka as fulfilling the item relationships from different collections. It also explores some scripts and semantic web scale services using digital object identifiers, uniform resource identifier, and uniform resource locations. However, users have very much benefited from using this semantic web technologies to designing and developing domain specific cultural heritage resources with the help of basic system integrated framework on the basis of global recommendations and local requirements as per metadata vocabularies. Now the whole integrated framework is designed on Ubuntu Operating System and LAMP architecture. This framework is very useful and effective for the users.

Keywords : Item Relationships, Semantic Web, Metadata, BIBO, FRBR, FOAF, and Dublin Core

Introduction

Cultural heritage resources preservation is one of the important aspects in modern web technologies. Metadata formats are also playing a vital role to designing an innovative integrated framework regarding different cultural heritage. There are a large number of open source tools and standards available in online platforms. But it has only selected popular software for easy data entry and management of digital materials such as images, archives, different files and formats (e.g. pdf, doc, mp3, mp4, and etc), audeo, video and other multimedias. Item relationships are created and generated with the help of metadata vocabulary standards such as Dublin Core, BIBO (Bibliographic Ontology), FOAF (Friend of a Friend), and FRBR (Functional Requirement for Bibliographic Records). Linked data management is possible in a semantic web environment with the help of digital object identifier and uniform resource identifier. Item relations are configured and designed with the help of xml, html, RDF, SPARQL, and other supported scripts. Users have accessed data about data and full text materials from different items and collections available in digital repositories are a simple way to think about the who, what, when, and where about the items you want to describe. Metadata is important in semantic web scale discovery services for interoperability and crosswalk from one system to another by different tags and components (e.g. Title, LC Subject, Local Collection ID, Repository, Description, Conditions of Source, Identifier, Rights, Local Collection Name, Type, Format, Extent, Set, Has Version, Institution and etc.). These metadata vocabulary are transformed and interchanged from one machine to another machine with the help of modern open source tools and scripts. Dublin Core Metadata Initiative metadata terms are expressed in semantic RDF vocabularies using Linked Data for easy access of parallel resources available in online heritage platforms. The URIs in linked data for namespaces are often display as prefixes in order to make data, queries, and schemas more concise and human-readable labels assigned to the term. Citation ontology

is identified by BIBO metadata vocabulary on the semantic web RDF for converting other bibliographic data sources. FOAF is a web based project for easy linking of people and information with the help metadata. It works in three kinds of networks (i) social network (ii) representational networks (iii) information networks. So, FOAF is look like a linked information systems in social networking level of applications, software systems, and services. The Semantic Web technologies facilitates to the users with an architecture for collaboration, allowing complex technical challenges to be shared by a loosely-coordinated community developers. Item relationships can achieve using FRBR components such as work, expression, manifestation, and item for digital heritage resources with the help of metadata vocabularies.

Structure of Basic Framework

The structure of basic framework is depends on three aspects for designing and developing of domain specific system. However, these three components are software, supporting software, and item relations standards. This Figure -1 has shown all the software and standards for the betterment of heritage resources both in online and offline environment. In case of software: Omeka has been selected. Here supporting software are Linux, Apache, MySQL, and PHP. Item relations standards are Dublin Core, BIBO, FOAF, and FRBR. These four standards are very important and essential in linked data management for item relations in different collections available in online heritage. There are different sub-fields and tags available which based on RDF, XML, JSON, MARC-XML, MODS-XML and SPARQL format and etc. Bibliographic ontology and metadata vocabulary are being created using this basic systematic integrated framework. Digital object identifier and uniform resource identifier are also being possible from this systematic approach to fulfilling the users requirements and their satisfactions both in online and off-campus platform. Now the present search interface and processes are changed due to change in technological concepts and ideas, for solving this problem, the research paper has formulated the nascent software and standards in managing the Museum and heritage resources. The common access and data entry framework has been generated using some scripts and plugin for Dublin Core, BIBO, FRBR, and FOAF. All the newbie users have been benefited for advanced level access of resources regarding both metadata and fultext in semantic web plus linked data environment.

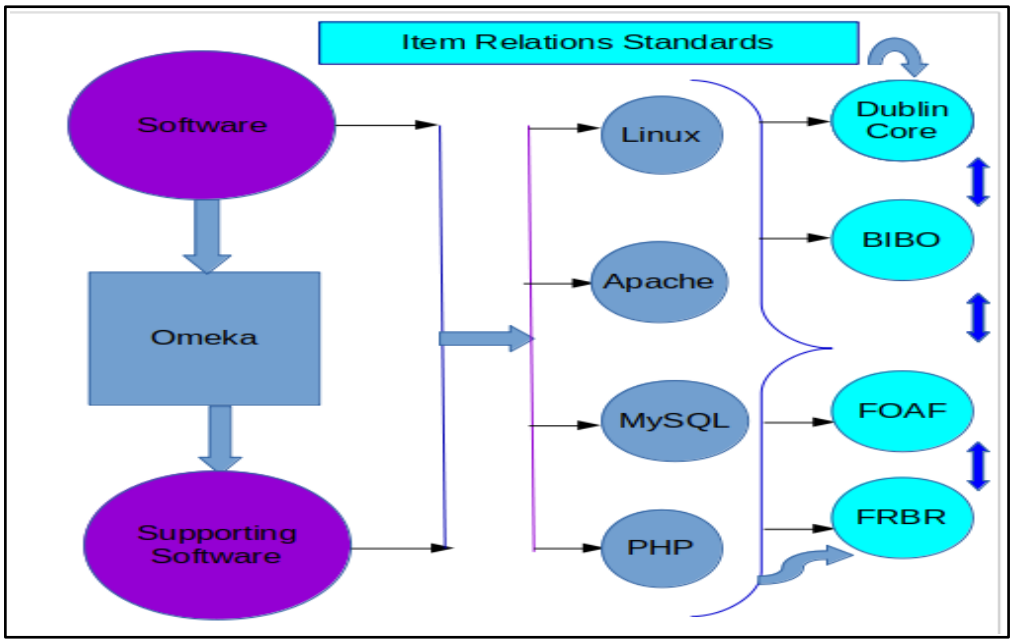


Figure – 1 : Structure of basic framework

Review of related works

It explores the availability of embedded metadata within images of digital cultural resources where most digitally derived images (Saleh, 2018). The essential purpose of this paper is an example of how ontology, such as CIDOC, can be turned into a format from the perspective of an object which represents semantic analysis in view neutral machine-interpretable form (Farrokhnia & Zarei, 2013). The paper provides information professionals with descriptive metadata standards and collection management systems used for managing documentary heritage collections held by cultural heritage institutions in New Zealand (Renshaw & Liew, 2021). The authors are exploring multilingual access in digital libraries and to present a case study of creating bilingual metadata records for the Tse-Tsung Chow Collection of Chinese Scrolls and Fan Paintings (Matusiak...et.al, 2015). The authors have created a new model for annotations and semantic web enhancement of cultural heritage resources (Wang...et.al, 2021). The authors overview of the Illinois project, presents quantitative data about divergent metadata practices for metadata providers and harvesting services (Shreeves, Kaczmarek & Cole, 2003). It introduces a new framework with the help of digital tools and techniques which aims at tackling the cultural data enrichment challenge using machine learning (Belhi...et.al, 2020). The paper explores a detailed method and MARiMbA a tool for publishing linked data out of library catalogues for publishing and sharing in the MARC 21 format (Vila-Suero & Gómez-Pérez, 2013). This study is based on the current state of the development of linked open data bibliographic portals to discuss regarding the value added services and functions (Alvite-Díez, 2021). This paper highlights and overview a model which provides for interoperability by means of semantic metadata crosswalks and facilitates the fusion of information resources stored from homogeneous and heterogeneous sources (Leiva-Mederos...et.al, 2017). This paper has discussed the citation data formats needs to be recognised as a part of the commons for researchers which are freely and legally available for sharing and placed in an open repository (Peroni...et.al, 2015). It provides the current trends of the existing research on the application of semantic technologies in bibliographic databases (Georgieva-Trifonova, Zdravkov & Valcheva, 2019). Bibliography acquisition methods to verify the bibliography by author name from the integrated system and digital object identifier proxy (Ma & Yang, 2014). The purpose of this paper is to discuss the applications of Web 2.0 and Library 2.0 concepts to increasing the semantic search facilities (Burke, 2009). This study is based on information seeking for the students with the help of Wikipedia on iPod touch (Hahn, 2010). It has explained a system which facilitates querying across distributed digital libraries created in heterogeneous metadata schemas without requiring the availability of a global schema (Ding & Sølvberg, 2007). The objective of this paper is to overview a study which is based on how non-experts in bibliographic systems map the bibliographic universe and how they conceptualize relationships between independent but strongly related entities (Tallerås, Dahl & Pharo, 2018). Metadata vocabulary concepts and ideas have been recommended on the basis of IFLA for designing and transforming FRBR, RDF, and BIBFRAME for bibliographic linked data (Baker, Coyle, & Petiya, 2014). It focuses on the application of BIBFRAME for creation of linked data from MARC 21 bibliographic for easy access of metadata and URI (Kim, Chen & Montgomery, 2021). This paper is to explore and highlight the potential strengths and weaknesses of the BIBFRAME bibliographic model (Park, Richards & Brenza, 2019). Linked data tools and techniques can change the cataloging process and formats in the web environment (Williams, 2021). This paper has studied the development of cataloguing standards by using linked data concepts to organize information sources in libraries and information centers (Wahid, Warraich & Tahira, 2018). This paper introduced a methodology for automatic annotation of multimedia items and collection of intangible cultural heritage mostly in the form of interviews which were based on annotations (Tanasijević & Pavlović-Lažetić, 2020). The Open Archives Initiative Protocol for Metadata Harvesting presents one promising method for creating metadata terms which more interoperable and crosswalk from one machine to another (Prom, 2003).

Objectives

The objectives of this paper of an integrated prototype framework for item relationships are pointed as below:

(i) To explore the metadata vocabulary standards for heritage resources.
(ii) To show the practical steps and techniques for designing the item relationships in different items and collections.
(iii) To integrate the process of different metadata linked vocabularies in users and admin interfaces.
(iv) To develop the data entry interface for item relations and collections.

Software Selection Process

Software has been selected on the basis of global recommendations of the digital library federation. Server side software are: (i) Apache: Apache is a web server for hosting and running the heritage management resources with the help of a high relevant web browser i.e Firefox. Configure the apache web server under (etc/apache2/sites-available) on Ubuntu operating system for easy access and download of digital resources. Operating System: It has been selected as the high reliable software Ubuntu Operating System. (ii) MySQL: Select MySQL for database connectivity during installation of different tables and modules. (iii) PHP: Install the php software on Ubuntu-20.04 LTS version using the command (sudo apt-get install php). (iv) Omeka: This is the main software for designing the item relationships with the help of open source metadata standards and techniques (described in next section). Now the question is how to install and configure the Omeka software on Ubuntu Operating System. But this is very easy to install and configure the said software as per the instructions of Omeka Website (**https://omeka.org/**). It provides two interfaces for administrators and users.

For Administrators URL	:	http://localhost/omeka/admin/users/login
For Users URL	:	http://localhost/omeka/

Selection of Standards and Components for Item Relationships

Most popular four standards have been selected for designing and developing the digital cultural heritage with the help of item relationships in different collections. These standards are as follows: (i) Dublin Core ; (ii) Bibliographic Ontology (BIBO) ; (iii) Friend of a Friend vocabulary (FOAF) ; (iv) Functional Requirements for Bibliographic Records (FRBR). However, these can be described as below:

Dublin Core

Generally it consists of fifteen elements. But these components have been extended for providing vocabularies with the help of DCMI metadata terms. It is based on Linked data and RDF formats such as XML, JSON, UML, URI, and other advanced visualization facilities. This is the combination of metadata terms and vocabularies of application profiles. Now, the important components of Dublin Core as pointed below for organizing the modern digital cultural heritage. Name space URI is found from this link http://purl.org/dc/terms/ regarding the Dublin Core and controlled vocabularies.

Components of Dublin Core

dcterms:relation	dcterms:source	dcterms:instructionalMethod
dcterms:conformsTo	dcterms:abstract	dcterms:language
dcterms:hasFormat	dcterms:accessRights	dcterms:license
dcterms:hasPart	dcterms:accrualMethod	dcterms:mediator
dcterms:hasVersion	dcterms:accrualPeriodicity	dcterms:medium

dcterms:isFormatOf	dcterms:accrualPolicy	dcterms:provenance
dcterms:isPartOf	dcterms:audience	dcterms:publisher
dcterms:isReferencedBy	dcterms:contributor	dcterms:rights
dcterms:isReplacedBy	dcterms:coverage	dcterms:rightsHolder
dcterms:isRequiredBy	dcterms:creator	dcterms:spatial
dcterms:isVersionOf	dcterms:description	dcterms:subject
dcterms:references	dcterms:educationLevel	dcterms:tableOfContents
dcterms:replaces	dcterms:extent	dcterms:temporal
dcterms:requires	dcterms:format	dcterms:type

FRBR (Functional Requirement for Bibliographic Records)

FRBR stands for functional requirement for bibliographic records. These terms have been collected from the link of http://vocab.org/frbr/core.html for managing and organizing the digital resources. This is a type of vocabulary which is based on RDF classes of group 1, 2, and 3 entities and attributes on Functional Requirements for Bibliographic Records. The essential components of FRBR are shown below and it's very important to organize and design the digital cultural heritage in an online platform.

Components of FRBR

frbr:abridgement	frbr:imitation	frbr:owner
frbr:abridgementOf	frbr:producer	frbr:ownerOf
frbr:adaption	frbr:producerOf	frbr:part
frbr:adaptionOf	frbr:realization	frbr:partOf
frbr:alternate	frbr:realizationOf	frbr:revisionOf
frbr:alternateOf	frbr:realizer	frbr:successor
frbr:arrangement	frbr:realizerOf	frbr:successorOf
frbr:arrangementOf	frbr:reconfiguration	frbr:summarization
frbr:complement	frbr:reconfigurationOf	frbr:summarizationOf
frbr:complementOf	frbr:relatedEndeavour	frbr:supplement
frbr:creator	frbr:reproduction	frbr:supplementOf
frbr:creatorOf	frbr:reproductionOf	frbr:transformation
frbr:embodiment	frbr:responsibleEntity	frbr:transformationOf
frbr:embodimentOf	frbr:responsibleEntityOf	frbr:translation
frbr:exemplar	frbr:revision	frbr:translationOf
frbr:exemplarOf	frbr:imitationOf	

BIBO (Bibliographic Ontology)

The Bibliographic Ontology expresses bibliographic things based on RDF in the semantic Web environment. This is a type of ontology based on RDF which is used as a citation and document classification. Document description metadata formats can easily be converted in bibliographic format with the help of this script as below (available in https://www.dublincore.org /specifications/bibo/bibo/bibo.rdf.xml) and components of bibliographic ontology (Figure-2) are pointed as below for designing and organizing of cultural heritage on online and offline platform.

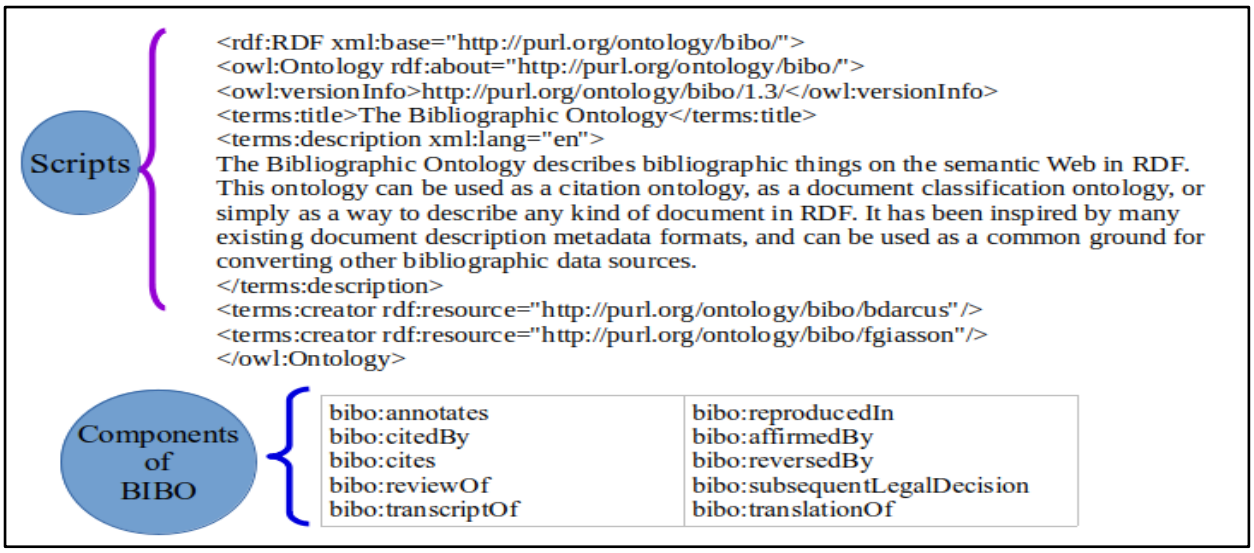


Figure – 2: Scripts and components of Bibliographic Ontology

FOAF (Friend of a Friend Vocabulary)

FOAF outlines the world through simple concepts and ideas in an online platform. This is a linked data concept regarding the links and kinds of things on properties. These types of things are called classes. So as to FOAF provides class and property based on RDF and XML syntax which encoding descriptive structure of network and FOAF script and components of Friend of a Friend vocabulary are very essential regarding the cultural heritage for easy retrieving and organizing of resources among the users and researchers.is shown as below in Figure-3:

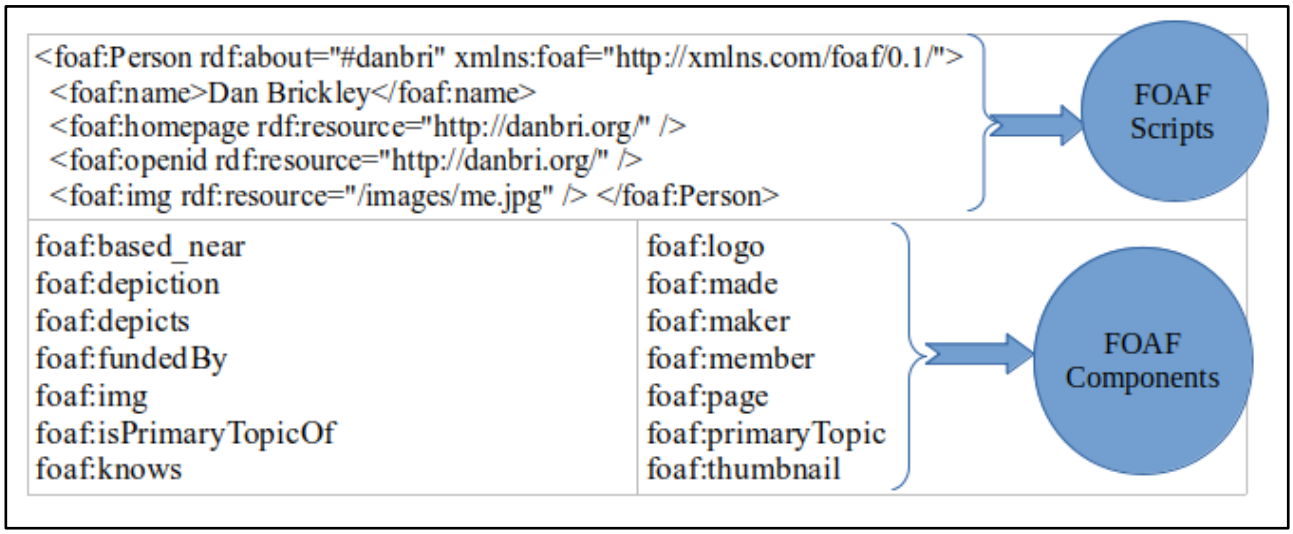


Figure – 3: Scripts and components of Friend of a Friend Vocabulary

Configuration of XML Scripts of Item Relations

Item relations are designed with the help of XML scripts and different tags and sub tags. It is based on UT-8 for managing the multilingual resources for digital cultural heritage.

```
<?xml version="1.0" encoding="UTF-8"?>
<project name="ItemRelations" basedir=".">
   <property name="lang.dir" location="languages" />
   <property name="core.pot" location="../../application/languages/Omeka.pot" />
   <target name="update-pot" description="Update the translation template.">
      <property name="pot.file" location="${lang.dir}/template.pot"/>
      <property name="pot.base" location="${lang.dir}/template.base.pot"/>
      <tempfile property="pot.temp" suffix=".pot"/>
      <tempfile property="pot.duplicates" suffix="-duplicates.pot" />
      <copy file="${pot.base}" tofile="${pot.temp}"/>
      <apply executable="xgettext" relative="true" parallel="true" verbose="true">
         <arg value="--language=php"/><arg value="--from-code=utf-8"/>
         <arg value="--keyword=__"/><arg value="--flag=__:1:pass-php-format"/>
         <arg value="--add-comments=/"/><arg value="--omit-header"/>
         <arg value="--join-existing"/><arg value="-o"/>
         <arg file="${pot.temp}"/><fileset dir="." includes="**/*.php **/*.phtml" excludes="tests/"/>
      </apply><exec executable="msgcomm"><arg value="--omit-header" />
         <arg value="-o" /><arg file="${pot.duplicates}" />
         <arg file="${pot.temp}" /><arg file="${core.pot}" />
      </exec><exec executable="msgcomm"><arg value="--unique" />
         <arg value="-o" /><arg file="${pot.temp}" />
         <arg file="${pot.temp}" /><arg file="${pot.duplicates}" />
      </exec><move file="${pot.temp}" tofile="${pot.file}"/>
      <delete file="${pot.duplicates}" quiet="true" />
   </target><target name="build-mo" description="Build the MO translation files.">
      <apply executable="msgfmt" dest="${lang.dir}" verbose="true">
         <arg value="-o"/> <targetfile /><srcfile />
         <fileset dir="${lang.dir}" includes="*.po"/>
         <mapper type="glob" from="*.po" to="*.mo"/>
      </apply></target></project>
```

Integration Interface of Dublin Core, BIBO, FOAF, and FRBR

This is the integration interface of item relations regarding different controlled vocabularies and metadata such as Dublin Core, BIBO, FOAF, and FRBR (Figure-4). It depends on the namespace prefix and namespace URI. Namespace prefix is dcterms and URI : http://purl.org/dc/terms/ for Dublin Core, BIBO for http://purl.org/ontology/bibo/, FOAF for http://xmlns.com/foaf/0.1/, and FRBR for http://purl.org/vocab/frbr/core# respectively. All the integrated interfaces have been designing and developing using Omeka open source software regarding the preservation of digital cultural heritage materials.

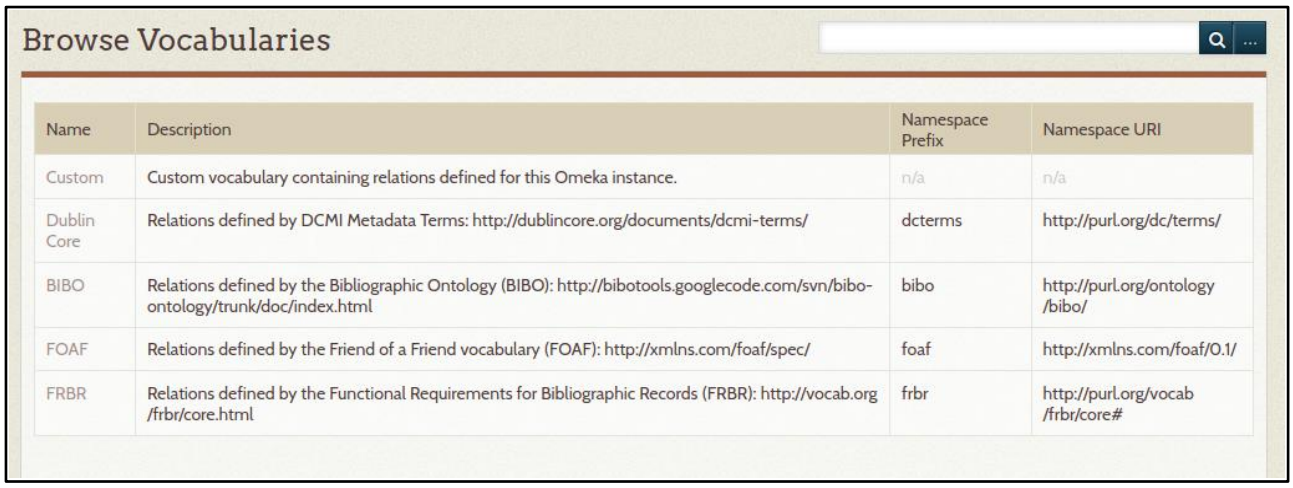


Figure – 4: Browse Vocabularies of Dublin Core, BIBO, FOAF, and FRBR

Designing and configuration of Item Relationships

This is very important and vital in creating item relations. It is possible to create and configure systematic item relations among different items and collections with the help of Omeka. Now steps are as below:

(i) Add Custom Vocabulary
(ii) Add Relationships
(iii) Add Interface of Dublin Core, BIBO, FOAF, and FRBR
(iv) Display relationships

(i) Add Custom Vocabulary

Adding property regarding different items vocabulary in three sections such as label, description, add property (Figure-5). It is also possible to edit and delete for exact item relations. This is a very important step in creation of metadata vocabulary for administrators and librarians.

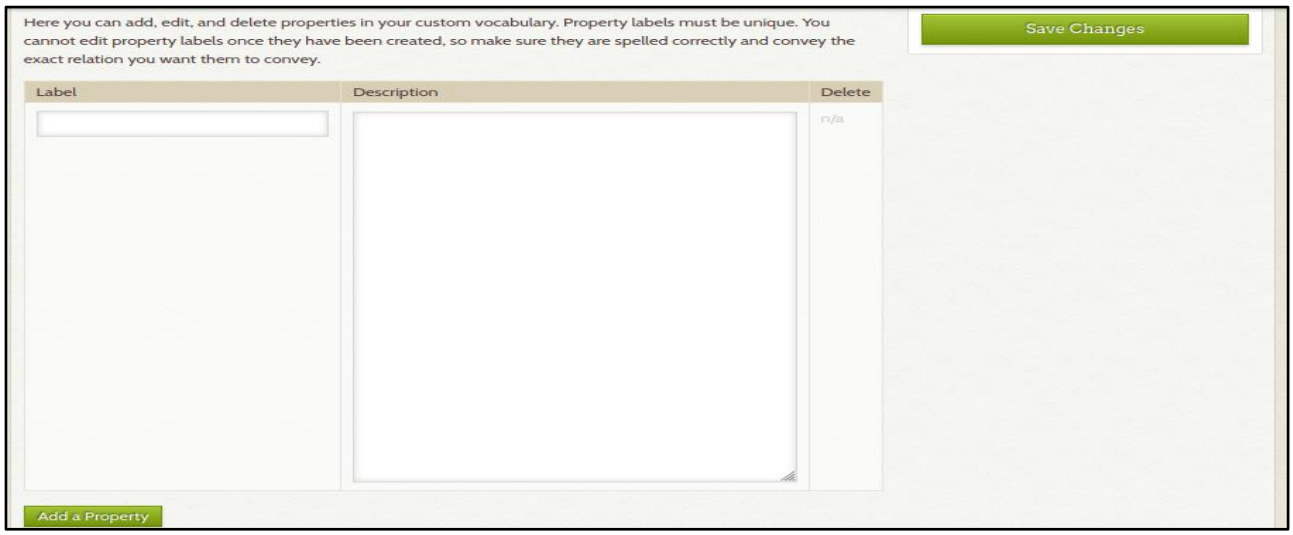
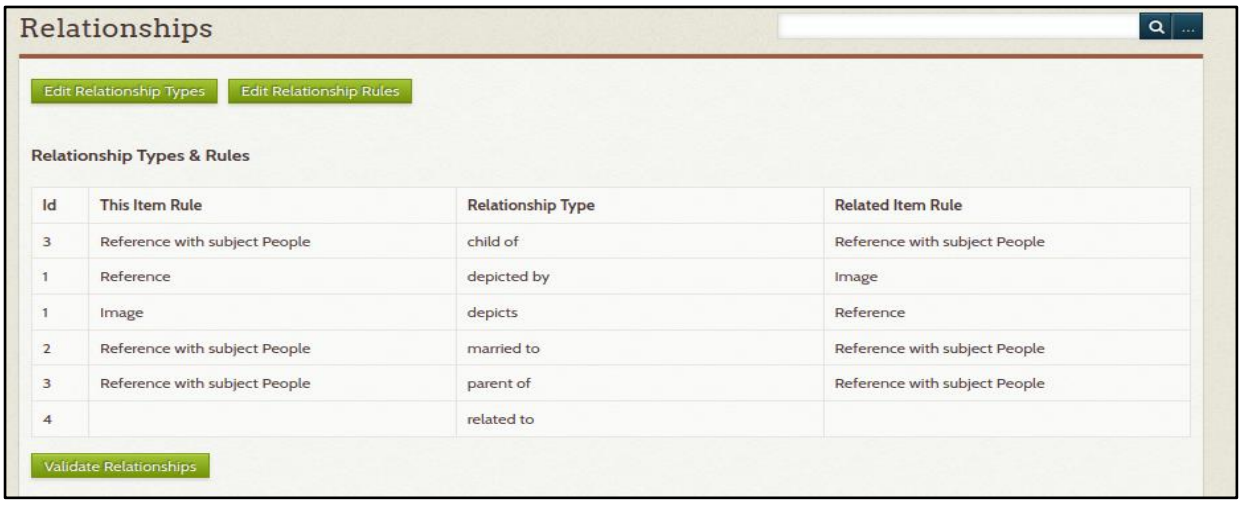


Figure – 5 : Add custom vocabulary

(ii) Add Relationships

It is classified in three fields such as edit relationship types, edit relationship rules, and validate relationships. Further relationships types and rules are categorized in four fields such as id, this item rule, relationship type, and related item rule (Figure-6).



Id	This Item Rule	Relationship Type	Related Item Rule
3	Reference with subject People	child of	Reference with subject People
1	Reference	depicted by	Image
1	Image	depicts	Reference
2	Reference with subject People	married to	Reference with subject People
3	Reference with subject People	parent of	Reference with subject People
4		related to	

Figure – 6 : Add relationships of different items

(iii) Add Interface of Dublin Core, BIBO, FOAF, and FRBR

This is the adding interface of items regarding the subject, relation, and object. It shows four items relations standards as Dublin Core, BIBO, FOAF, and FRBR (Figure-7). Web scale discovery services are being easily generated with the help of this integrated framework regarding items relations among the different collections.

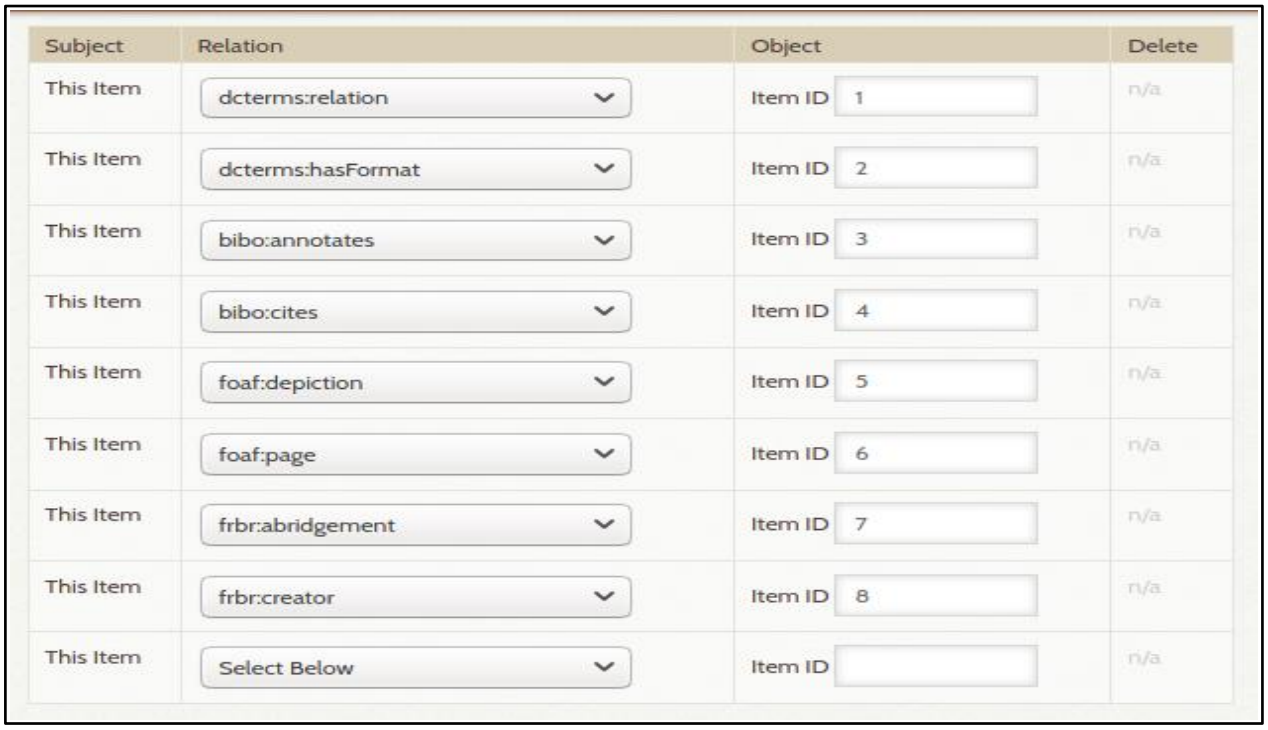


Figure – 7 : Add Interface of Dublin Core, BIBO, FOAF, and FRBR

This Figure has shown the item relationships of different titles (Figure-8). It has been created just by a single click on the Add button under the action field.

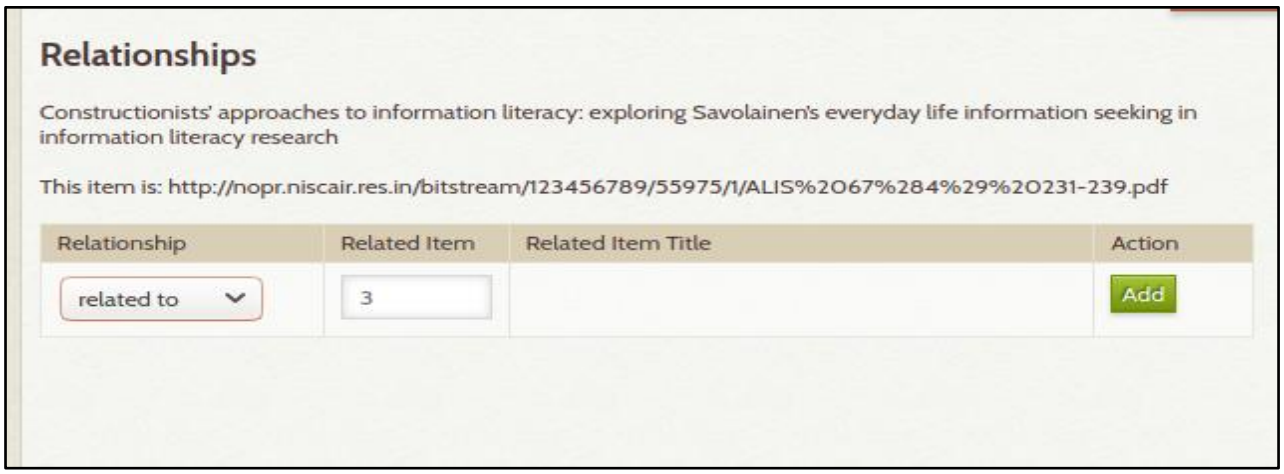


Figure – 8 : Add relationships of related item title

(iv) Display Relationships

This is a very user-friendly interface for digital items and collections. It is possible to display both visually and graphically the real world item relationships with the help of Omeka and plugin AvantRelationships for easy providing of images and related titles. Graphical visualization has been shown in the Figure-9 for providing the nice relationships among collections and items. Web scale discovery service has been generated using these tools and techniques for easy display of related items in different collections such as maps, research materials, documents, photographs, and etc. It shows the way people, houses, businesses, vessels, Acadia National Park, places, structures, organizations, and events.

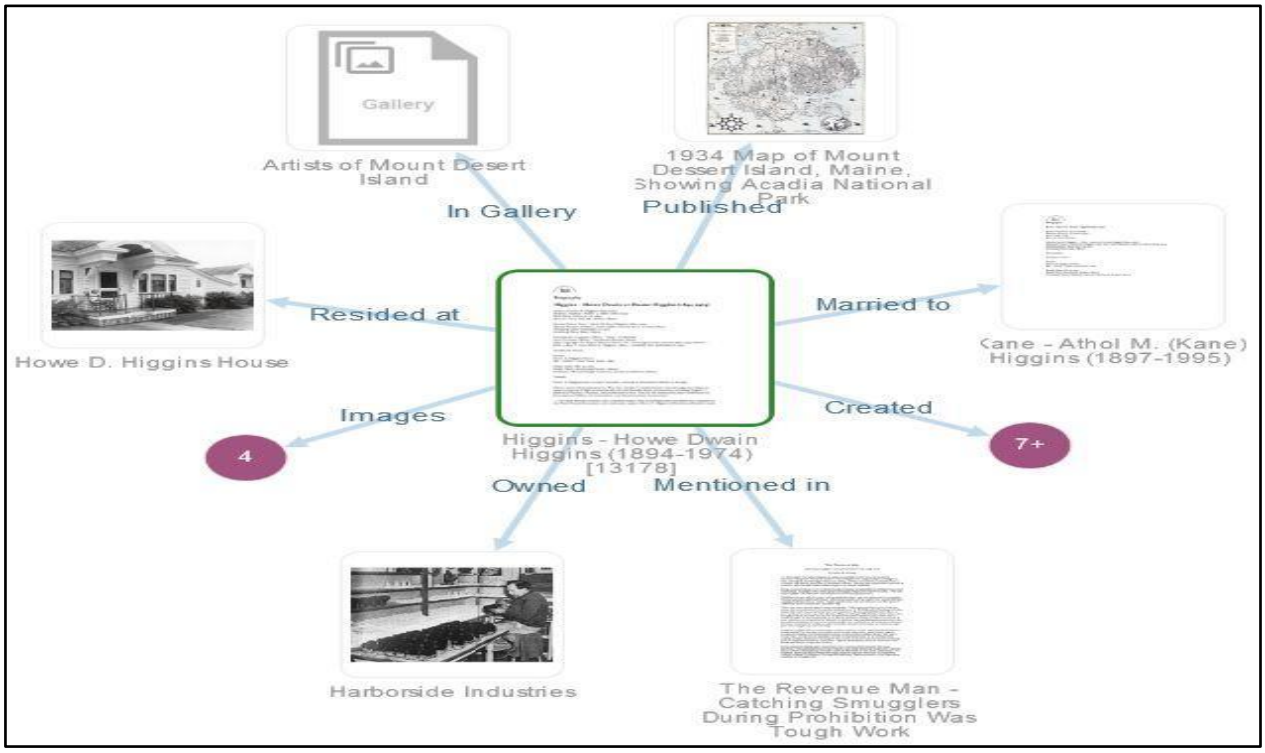


Figure – 9: Visual relationships of different items

Different Metadata formats have been displayed for item relations such as dcterms, bibo, foaf, and frbr. So it is possible to display these four metadata formats in the Figure-10 . This interface is very useful and informative in semantic web for managing the link vocabularies regarding different items and collections.

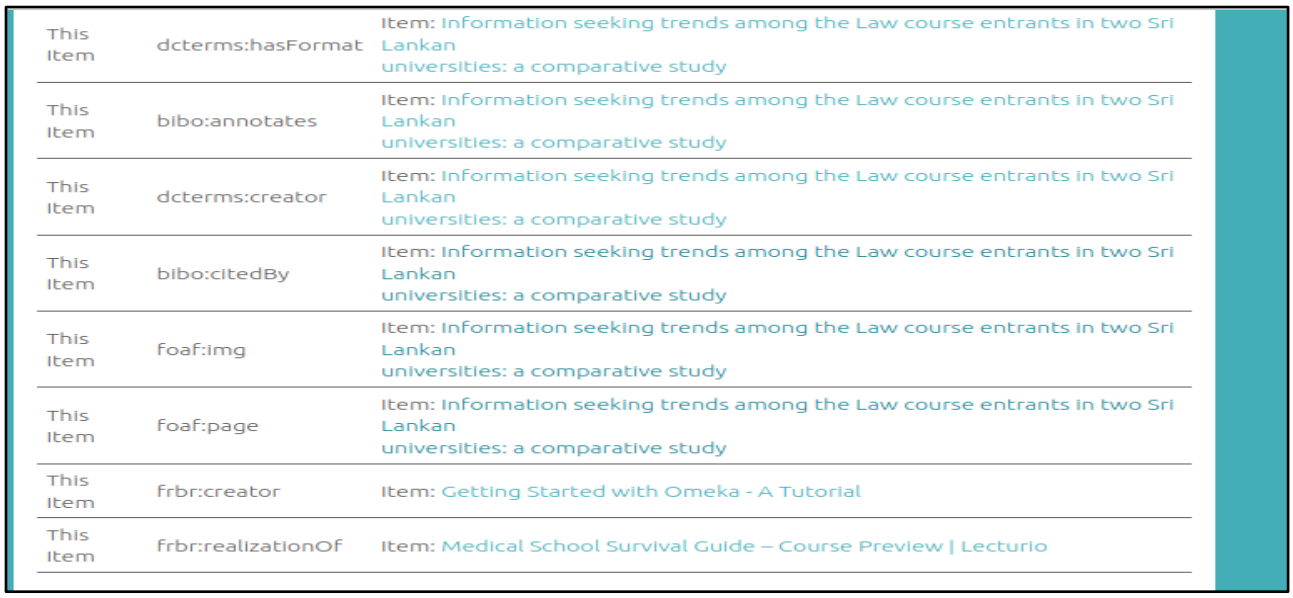


Figure – 10: Metadata formats for user interface

Conclusion

Metadata standards and open source software have created a full fledged interface regarding the cultural heritage of item relations. This is the single framework for creation of metadata vocabularies in semantic web scale environments. Semantic web scale services and linked data technology directly relates to open data strategies. This framework fully supports linked data and their cross collections search with the help of metadata scripts. From the above theoretical and practical discussions it is clear that item relationships possible with the help of four metadata vocabulary standards such as BIBO (Bibliographic Ontology), FOAF (Friend of a Friend), FRBR (Functional Requirement for Bibliographic Records), and Dublin Core. Taxonomy and ontology are easily created and generated with the help of this integrated framework. This is the concept of linked data vocabularies. Bibliographic linked data creation is possible through the components of BIBO (already discussed in the above section in BIBO metadata formats and scripts). Modern item relations are possible using FOAF techniques and scripts mentioned in the above section for easy management and access of social network sites. Work, expressions, manifestations, and items are generated with the help of FRBR metadata vocabularies. Actually these are the new and modern techniques scripts in heritage cultural resources. Item relations are easily created and generated with different terms of DCMI and relevant components for preserving the digital resources of cultural heritage. So, the users and

researchers are very attractive and benefited by using this integrated framework for easy access of different items and their appropriate relationships. The Figure-11 represents the item relations between different metadata formats and vocabularies in semantic and linked data environments. The framework has fully enabled the web scale discovery system and services for different items and collections. It is possible to manage the heritage resources regarding multilingual which enables good quality search interface and services in the context of cultural heritage institutions to improve the quality, openness and usefulness of their digital collections are vital.

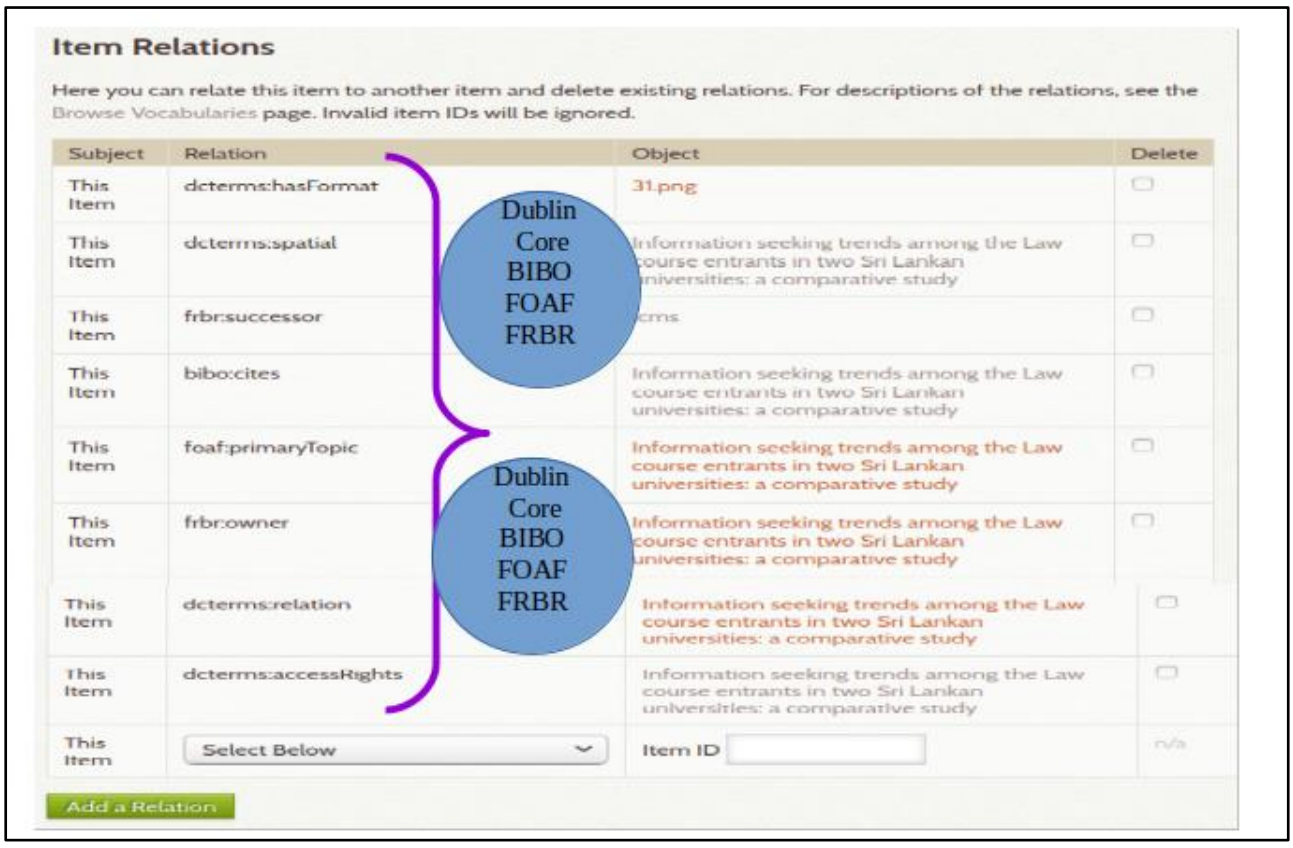


Figure – 11: Results of different items relations regarding subject and object

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